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The French Massif Central: a witness of successive weathering periods since the Early Cretaceous in the Alpine foreland

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Many European uplands have remained topographic highs for protracted periods of weathering during the Mesozoic and Cenozoic. The long-term elevation position as low relief of these massifs acted as a source for adjacent sedimentary basins, their weathering playing a major role in the production of sediments available for erosion. Weathering profiles on these uplands are mostly incomplete/truncated since weathering products have often been washed away during repeated periods of erosions, leading to patchworks of remaining weathered rocks. In order to better address the events that have shaped these source areas, a complementary approach of both the source (upland) and sink (sedimentary basin) areas is crucial, but the record in the hinterland often remains partial due to lack of dating material and incomplete sequence.

The study presented here after is part of the BRGM-TOTAL *Source-to-Sink* project and aims at identifying key periods of exposure of the Massif Central (France). We used the combination of a careful petrogenesis and $^{40}Ar/^{39}Ar$ dating of K-bearing Mn oxides (coronadite group and romanechite). The French Massif Central hosts several Mn occurrences sporadically mined until the first half of the 20th Century. We have targeted five of these sites that contain dating minerals: (1) "Nontronais" (Haute-Dordogne; Mn-Fe; south-west), (2) Villerembert (Montagne Noire; Mn; south), (3) Vieussan (Montagne Noire; Mn; south), (4) Auxilhac (Lozère; Mn-Fe; south), and (5) Romanèche (Mn-F-Ba; east). The combined petrography, mineralogy and geochemistry of these Mn ores show that Mn deposits 1, 2 and 3 belong to a weathering crust model ("laterite"), sampling site 4 follows a karst-hosted model whereas sampling site 5 follows an epithermal model. In any of these cases, the dated K-Mn oxides were formed at the end of the weathering paragenetic sequence, except maybe for Romanèche which encompasses epithermal formation. This and their oxidizing precipitation environment support a formation under surface or sub-surface conditions. Therefore, their ages are instructive of periods of meteoric waters circulation under near-surface conditions. For the first time in these areas, the $^{40}Ar/^{39}Ar$ ages define at least four weathering periods: (i) Albian and older, (ii) Campanian, (iii) Oligocene-Early Miocene and (iv) Late Miocene to Quaternary. The French Massif Central is a key place in the West European landscape that better constrain the long-term evolution of weathering that has affected basement rocks and their cover. The Early Cretaceous period is well known in Western Europe for having provided various and thick weathering products (bauxite, kaolin, siderolithic). The Campanian

age fits well with the first slow Pyrenean compression that exposed the Montagne Noire (south Massif Central), whereas Oligocene-Quaternary weathering events correspond to widespread weathering phases and compressional phases of the Alpine and Pyrenees. The lack of any Eocene period in the age record might be due to erosional conditions that overcome weathering, as it corresponds to the paroxysmal phase of the Pyrenean compression and strong siliciclastic discharge from the Massif Central to the Aquitaine and Paris basins.

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